



# Impact of Drift on the Vehicle Liftoff Acoustic Environments

Acoustical Society of America

5<sup>th</sup> Joint Meeting, Session 2aPA

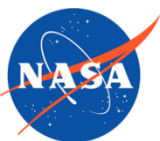
Acoustics of Supersonic Jets: Launch Vehicle and Military Jet Acoustics I

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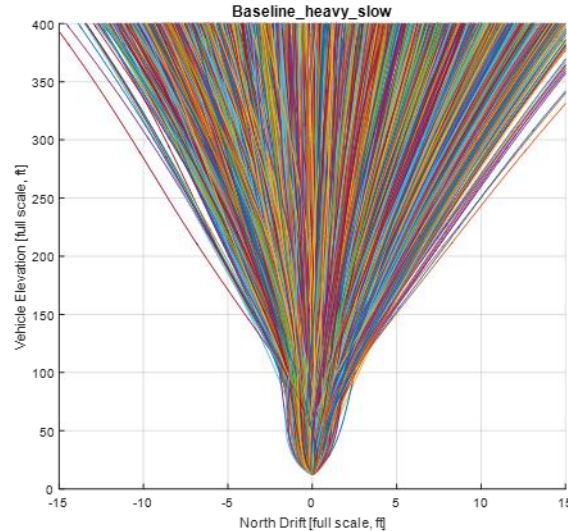
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# Introduction

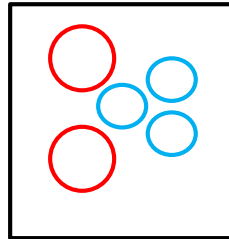
- As a launch vehicle lifts off the pad, depending on the flyaway maneuver, it will drift away from the exhaust hole causing the plume(s) to impinge on the launch deck.



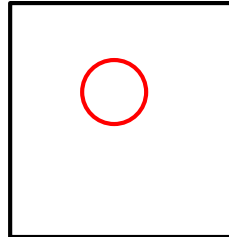
- This impingement on the deck creates acoustic sources and causes the noise levels on the vehicle to increase.
- The percentage of the plume which impinges on the deck can be calculated and related to sound pressure levels.
- Using this information, a  $\Delta$ dB can be calculated if the drift or flyaway maneuver for a specific vehicle changes during a program.

# Vehicle Differences

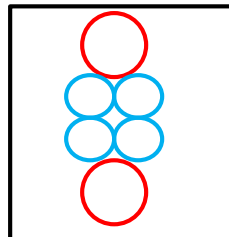
- Investigate whether the SPL is affected by percent impingement in similar ways for different vehicles
- Three scale model tests
  - 6.4% Shuttle (3 liquids, 2 solids)



- 5% Ares Scale Model Acoustic Test (ASMAT, 1 solid)

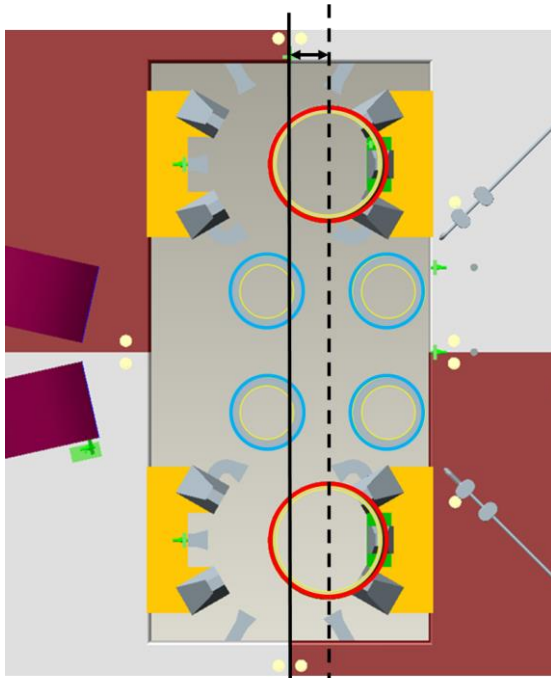


- 5% Scale Model Acoustic Test (SMAT, 4 liquids, 2 solids)

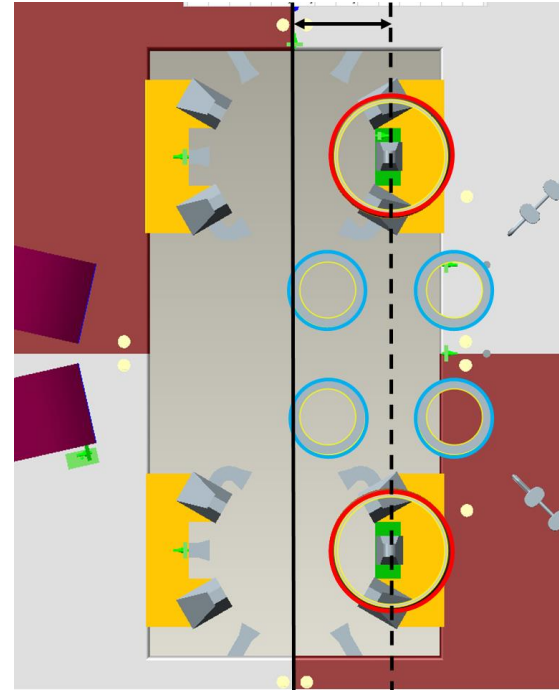


# Percent Impingement

- Calculated using SRB plume area and location

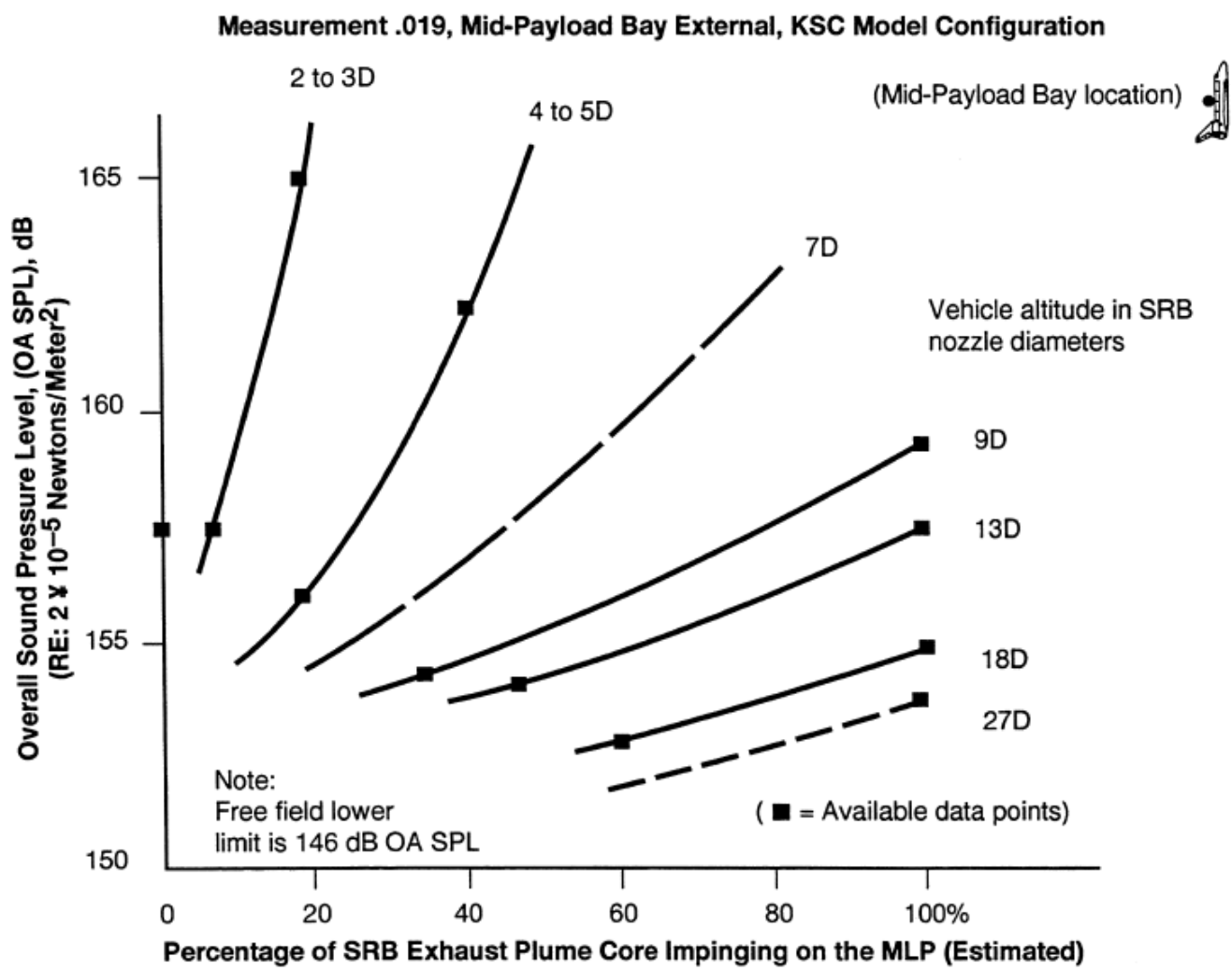


Depiction of 2.5" drift for the SMAT model. Solids are represented in red, thrusters are represented in blue.



Depiction of 6.125" drift for the SMAT model. Solids are represented in red, thrusters are represented in blue.

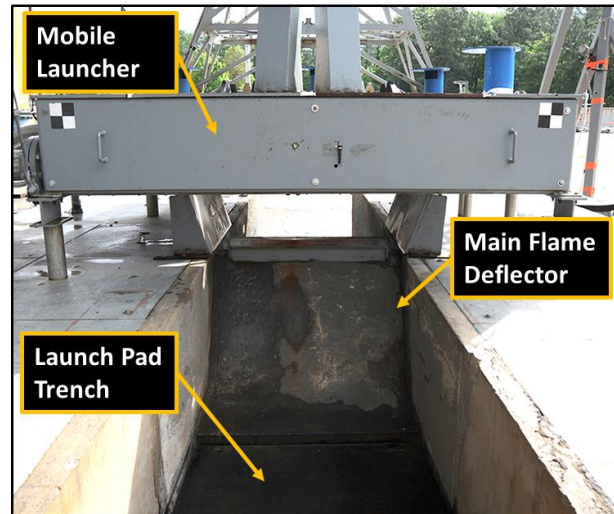
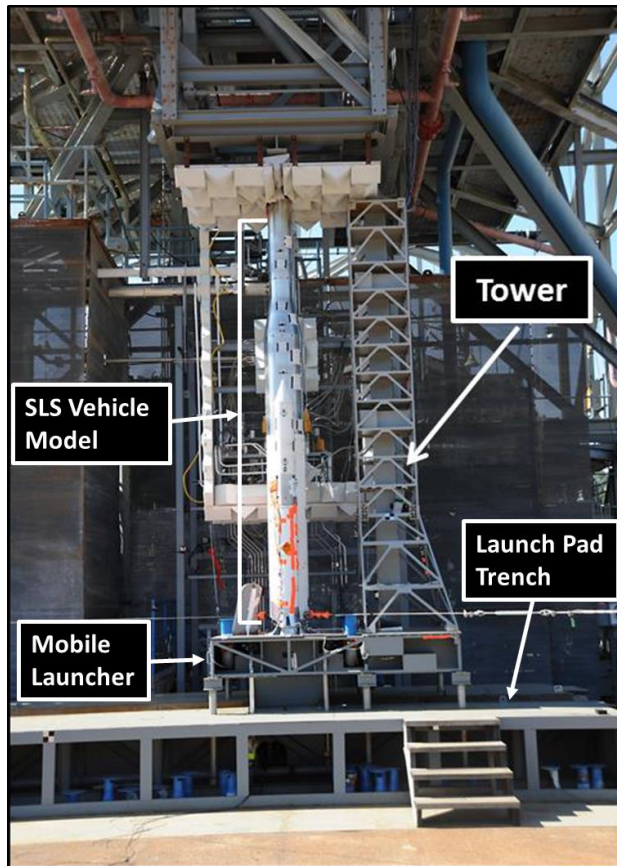
# Previous Work (STS scale model testing)



# SLS Scale Model Acoustic Test (SMAT)



- 5% scale model of SLS (vehicle, tower, mobile launcher)





# SMAT (continued)



- Tests at various heights and drifts
  - Simulates different liftoff trajectories



# Ares Scale Model Acoustic Test (ASMAT)



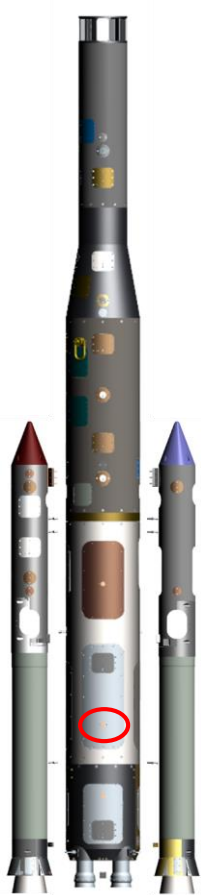
- 5% scale model of the Ares-I (vehicle, tower, mobile launcher)
- Tests at various heights and drifts
  - Simulate different liftoff trajectories





# Measurement Location

- To compare shuttle with SMAT and ASMAT, need to look at similarly placed measurements



Measurement I25, 60.8'

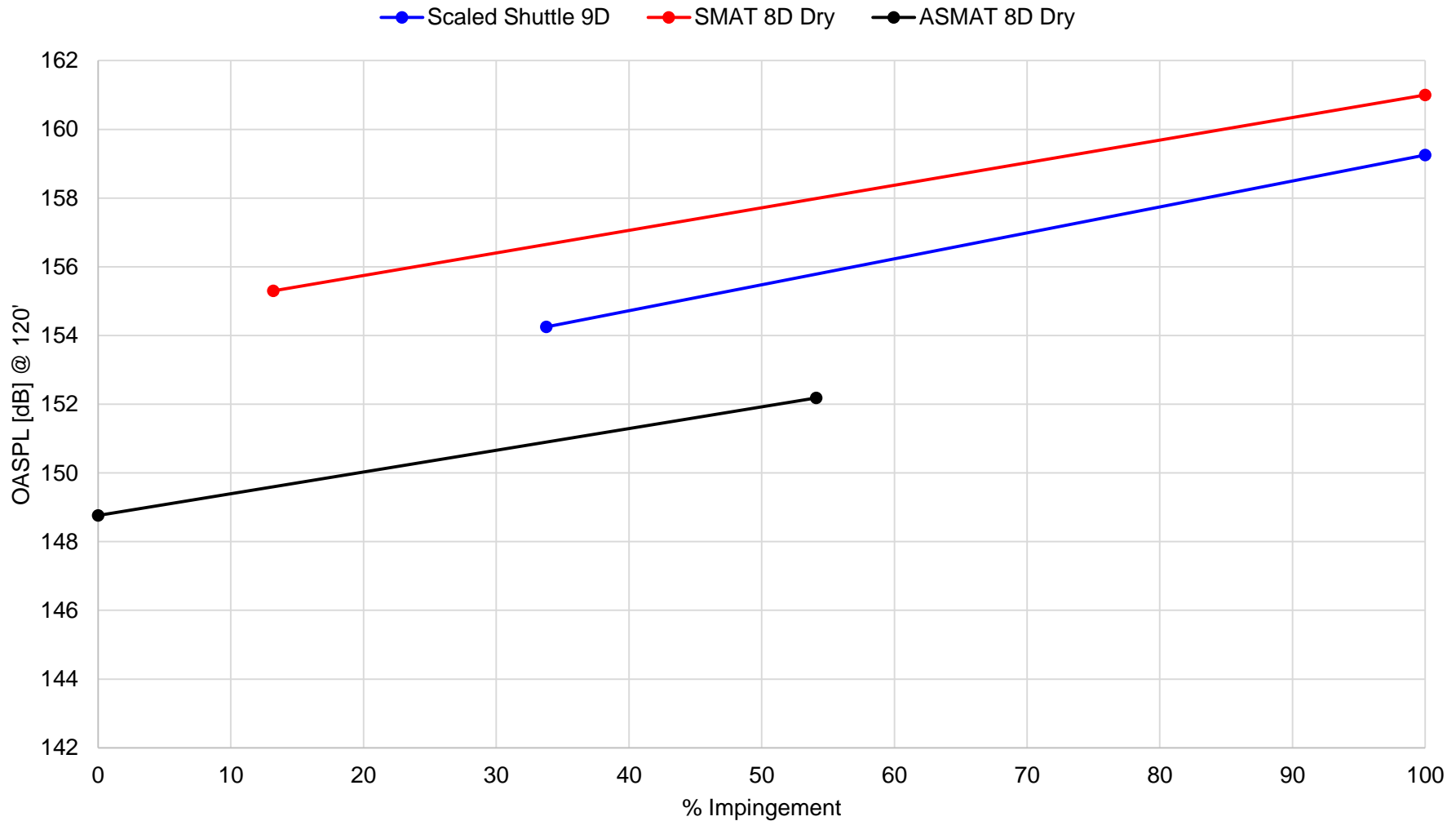


Measurement Z3, 118.6'



Measurement 019, 120'

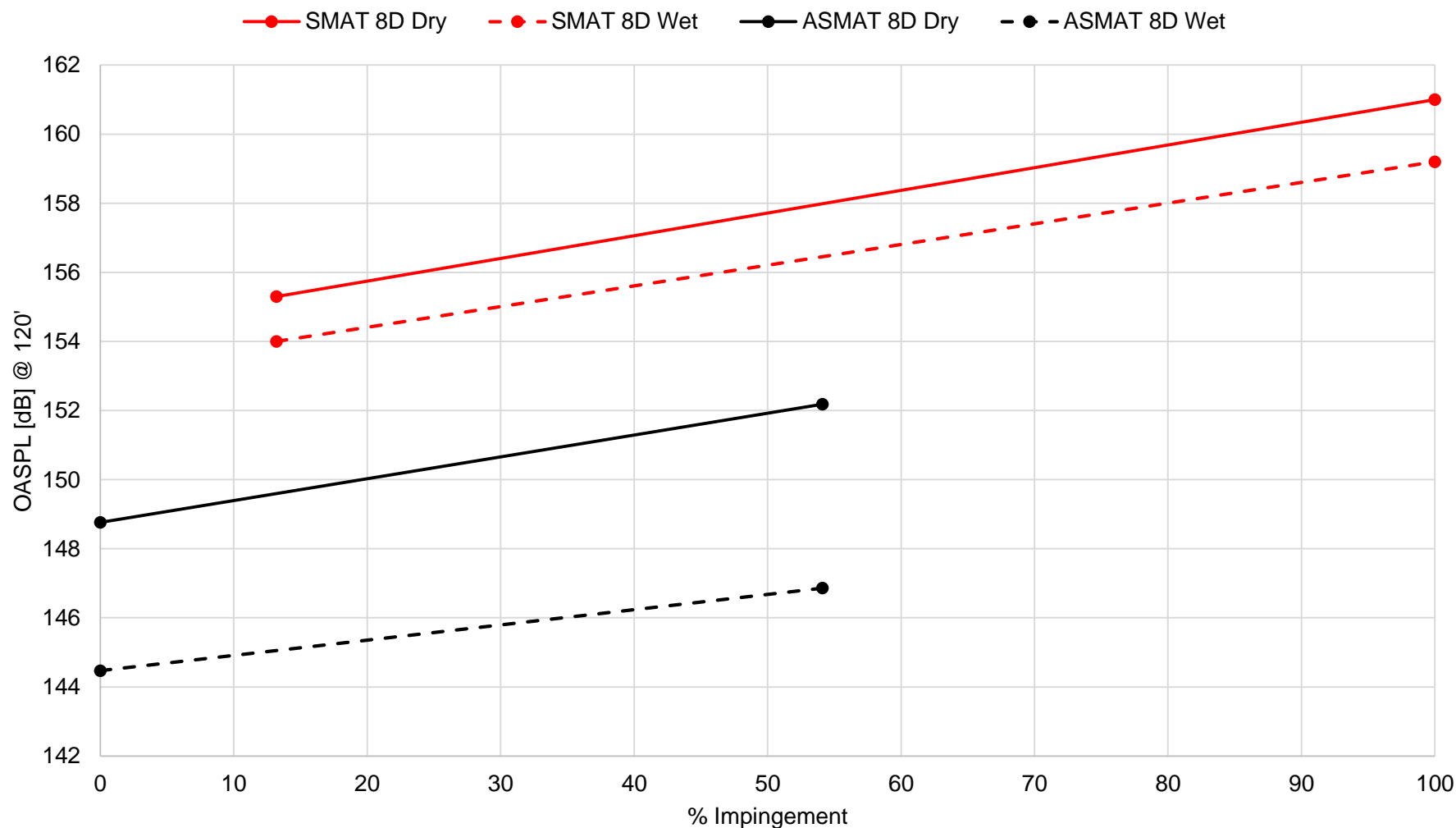
# Compare Vehicles



Absolute difference in OASPL due to differing measurement locations and vehicle power.  
Slopes are all very close – suggests good agreement between vehicles.



# Wet versus Dry



Slopes are all very close – suggests good agreement between wet v. dry conditions.

# Calculate $\Delta dB$

- Slopes obtained from this exercise can be used to calculate difference in SPL due to different impingements
  - $\Delta dB = slope * Percent\ impingement$
- For SMAT, slopes were calculated in each 1/3 octave band (250-63000 Hz) for each measurement location (19)
- Slopes were averaged across all frequencies and all measurement locations to obtain one generalized number
  - Different vehicle heights and wet versus dry were kept separate
- Comparison of actual  $\Delta dB$  (at locations used in this presentations) versus  $\Delta dB$  calculated using average slope

	$\Delta dB$ (SPL1 - SPL2)	$\Delta dB$ (Slope*%Imp)
SMAT 5' Dry	5.7	4.7
SMAT 5' Wet	5.2	5.7
SMAT 7.5' Wet	0.4	0.8
ASMAT 5' Dry	3.4	3.0
ASMAT 5' Wet	2.4	2.2

# Conclusions



- Compared effect of vehicle drift on sound pressure levels between three scale model tests
- Shuttle versus Ares versus SLS configurations all compare well despite being very different
- Wet versus dry configurations compare well
- The slopes calculated from this exercise can be used to calculate  $\Delta$ dB experienced by vehicle due to increasing/decreasing drifts and impingements





# THANK YOU

# QUESTIONS?